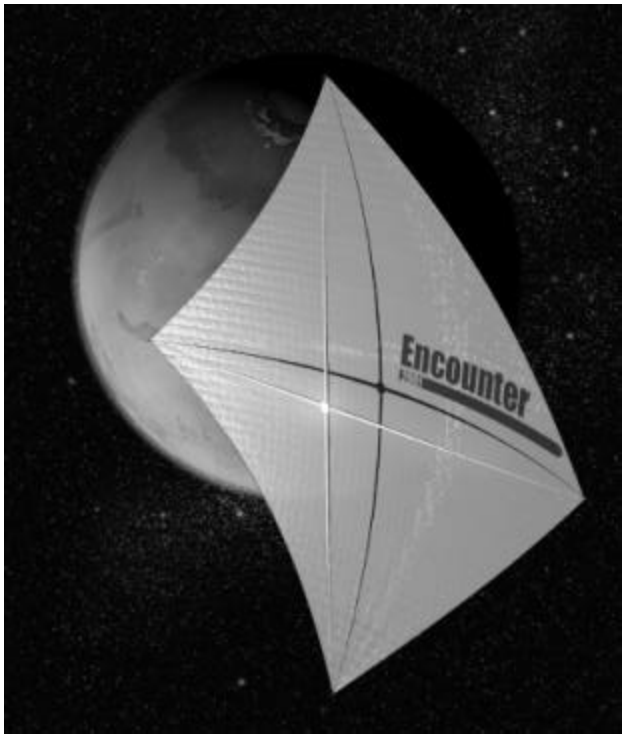
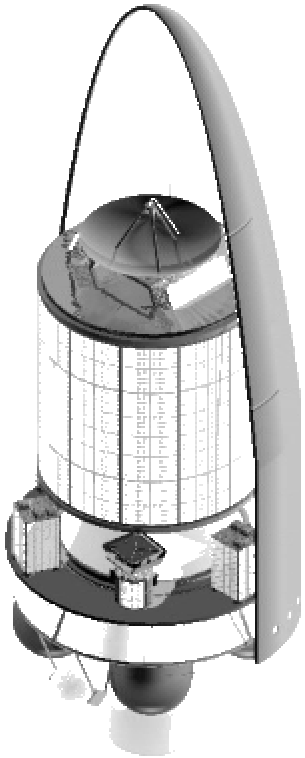
MISSION CONFIGURATION

MISSION OBJECTIVE



- **Deliver approximately 3 kg of payload to solar escape velocity**
- **Optimization Criteria**
  - Maximize corporate sponsorship opportunities
  - $20 million or less
  - High likelihood of mission success/insurability
  - Launched before the end of 2003

MISSION PLAN

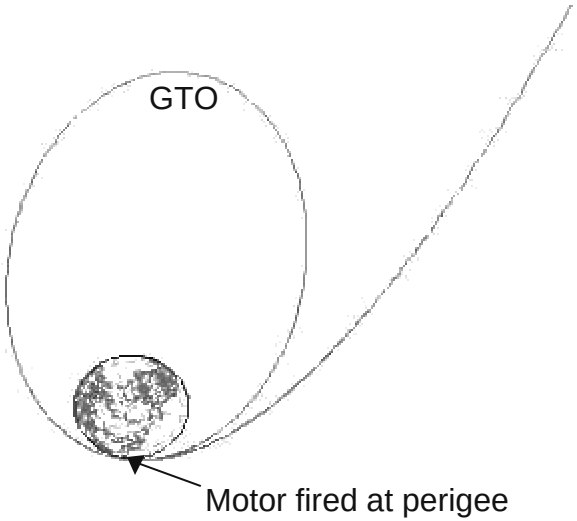


Team Encounter spacecraft attached to the ARIANE V ASAP ring

- **Spacecraft launch as secondary payload on Ariane 5 (ASAP ring)**
- **Spacecraft has two parts:**
  - Carrier
    - Gets sail to release point
    - Transmits video of sail to earth
  - Sailcraft
    - Carries 3 kg payload to solar escape

MISSION PHASES

- **Launch**
- **GTO/checkout**
  - System test
  - Rehearse internet video streaming
  - Spin up, fire solid motor at perigee to escape Earth's gravity

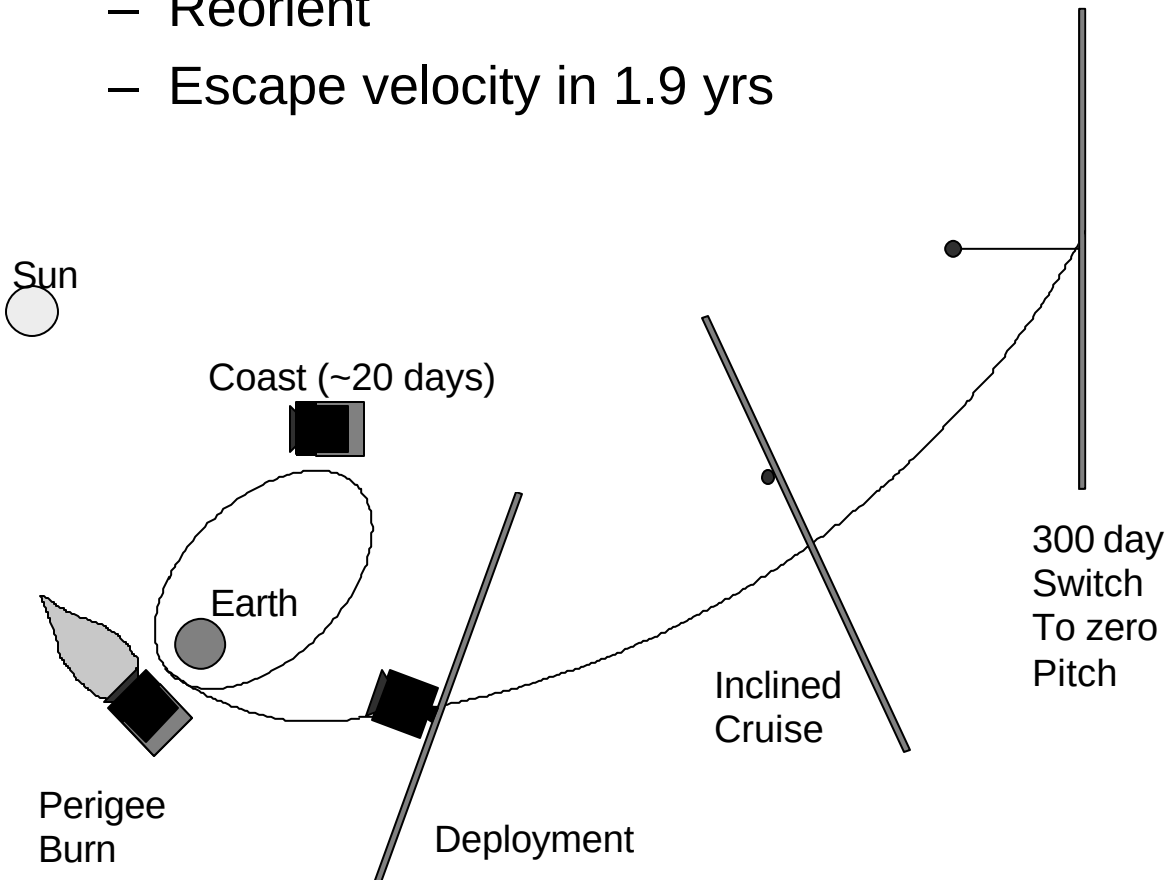


MISSION PHASES

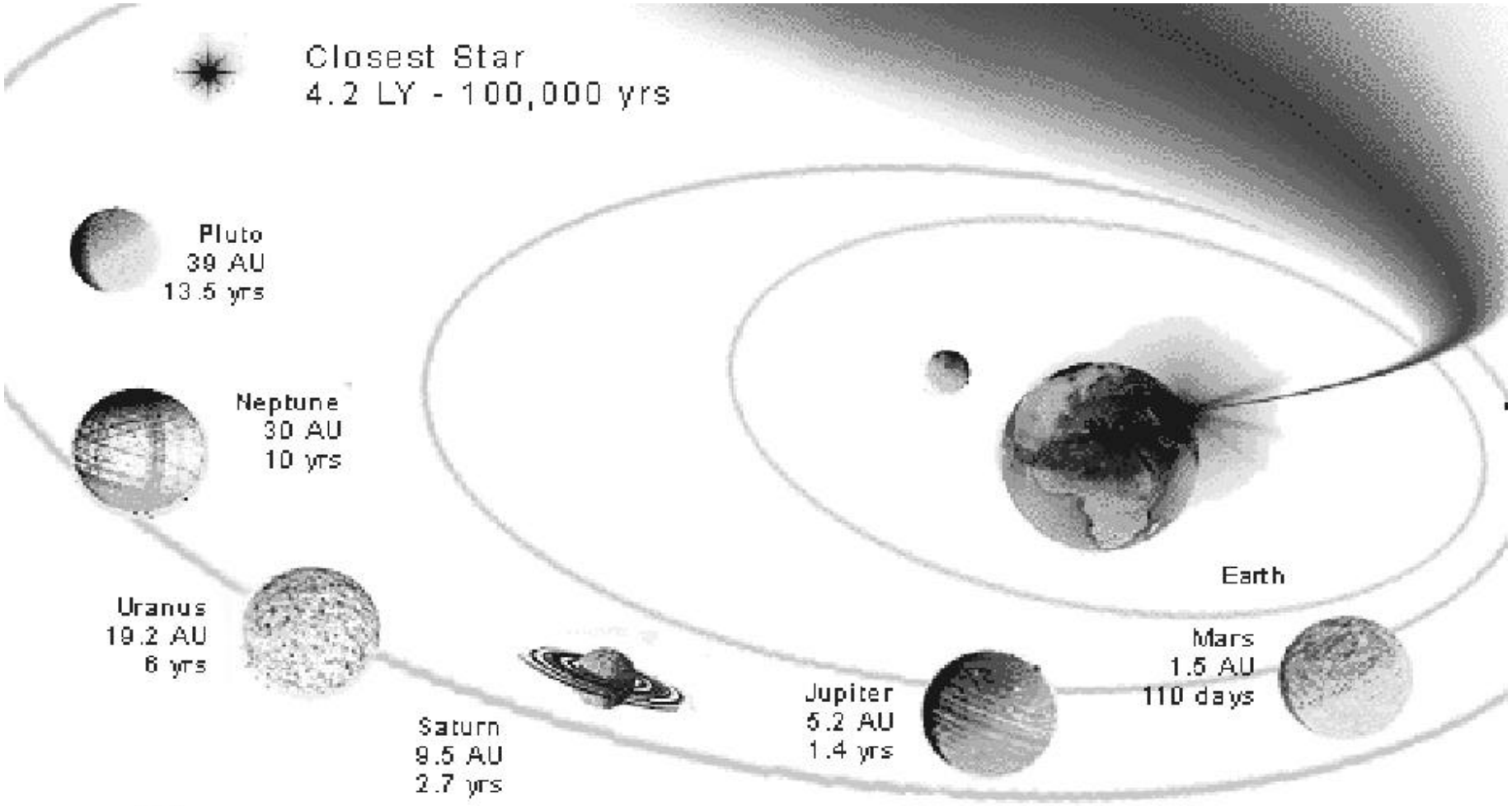
- **Sail Deployment**
  - Inflate booms, let rigidize
  - Orient sail for release
  - Release sail, transmit images

MISSION PHASES

- **Solar sailing**
  - First 300 days, “jibbing” away from the sun
  - Reorient
  - Escape velocity in 1.9 yrs

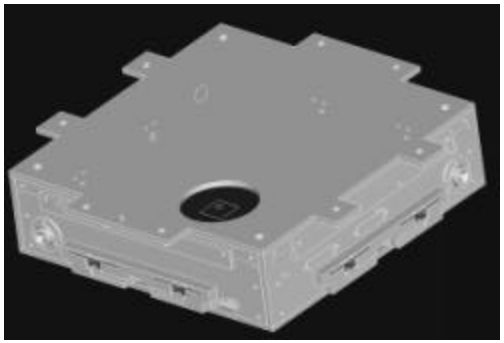


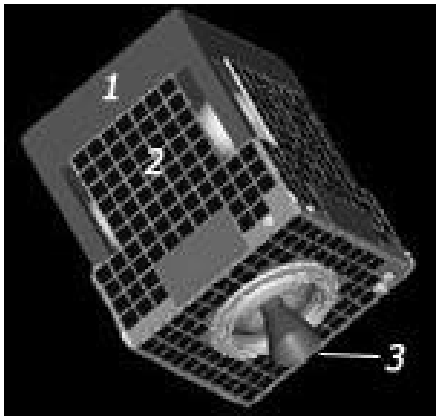
ESCAPE ANALYSIS

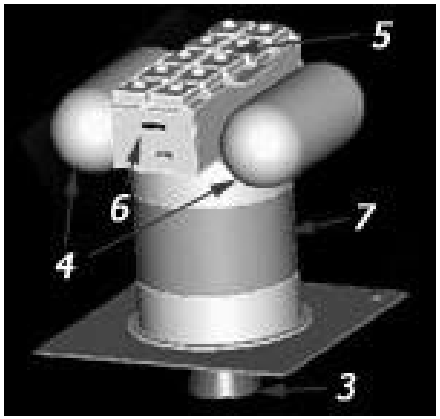


Velocity after engine burn 29.8 km/s, approximately 4 times the speed of shuttle

SPACECRAFT LAYOUT







- **Built around "Bitsy-SX" spacecraft kernel**
  - No onboard autonomy
  - Command and data handling
  - Power supply and regulation
- **Overall dimensions:**

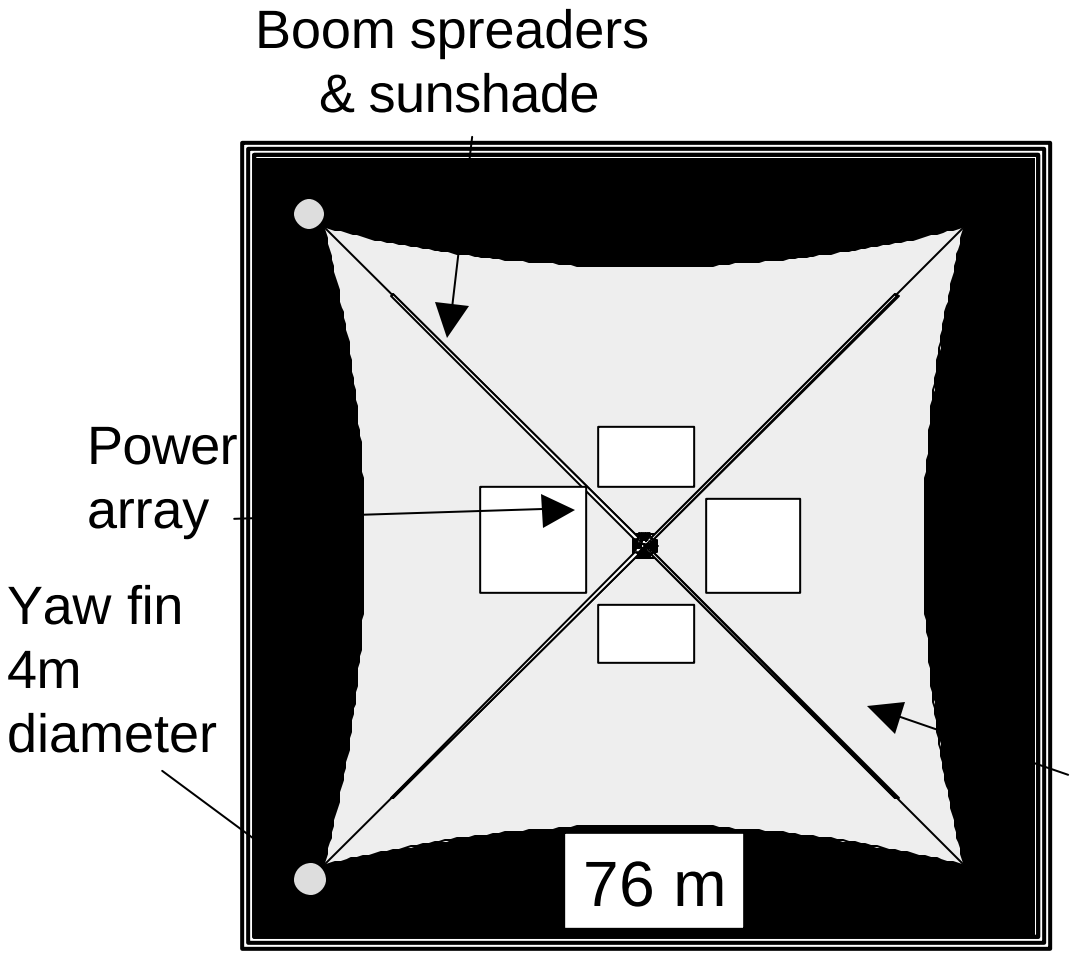
  70 cm x 58 cm (2.3 ft. x 1.9 ft)

- **Additional hardware**
  - Propulsion
  - Attitude Control and Determination
  - Communications
  - Imaging cameras
- **ASAP 5 allowed dimensions:**

60 cm x 60 cm x 71 cm (above separation plane)

1. Stowed Solar Sail ; 2. Side Solar Panels; 3. Thruster ;4. Cold Gas Tanks; 5. Imaging Cameras (10X) ; 6. BITSY™ -SX ; 7. STAR 12G Solid Motor

SAIL CONFIGURATION



- **Sail material:**
  - mylar: 0.9 mm (~0.000035 in.)
  - Front: aluminum metalization
  - Back: chromium metalization

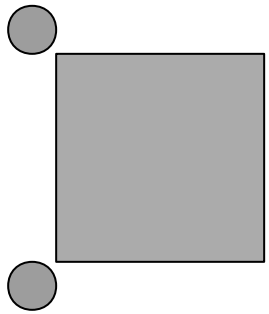
Overall sail dimensions:

76.4 m x 76.4 m (250 ft. x 250 ft.)

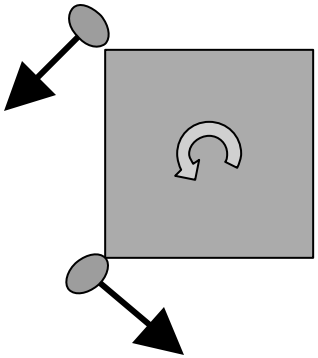
Life expectancy: exceed 10 yrs.

Sailcraft Active Yaw Stabilization

- **Yaw cannot be passively stabilized**
- **Active stabilization is required**
- **Yaw sensor measures orientation relative to fixed star field**
- **Rotation of yaw tabs produces torque similar to a pinwheel**



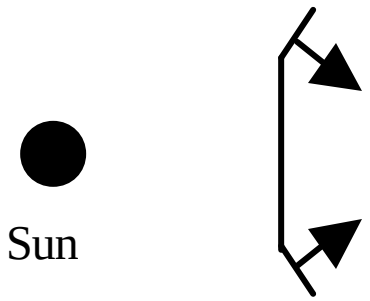
Zero actuator angle:
Yaw tabs produce
zero moment



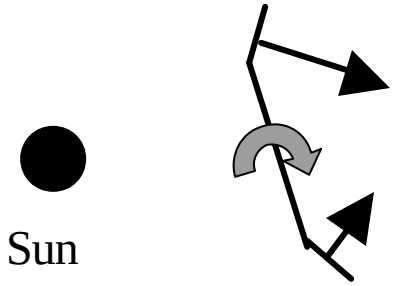
Positive actuator angle:
Solar pressure on tabs
creates A
“pinwheel” moment

Sailcraft Passive Roll/Pitch Stabilization

- **Pitch and roll can be passively stabilized**
- **Passive stabilization requires no power**
- **Pitch and roll tabs produce restoring moments**
- **Similar to the function of a vertical tail on an airplane**

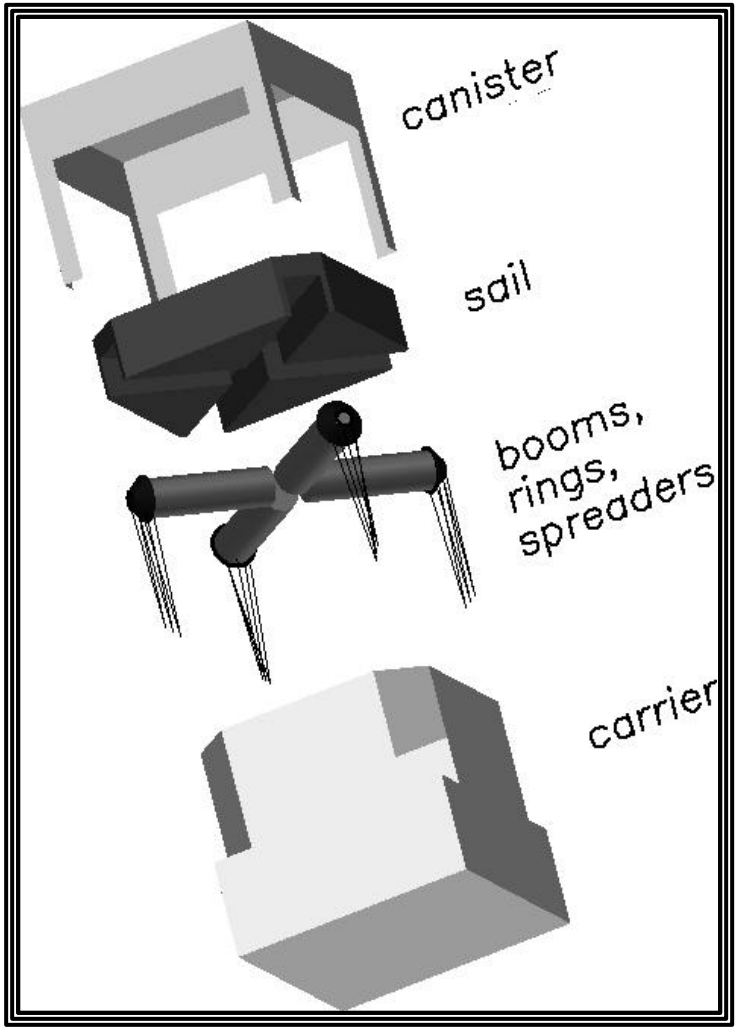


Zero Pitch:
Tab moments balance



Positive Pitch:
Solar pressure on tabs creates a restoring moment

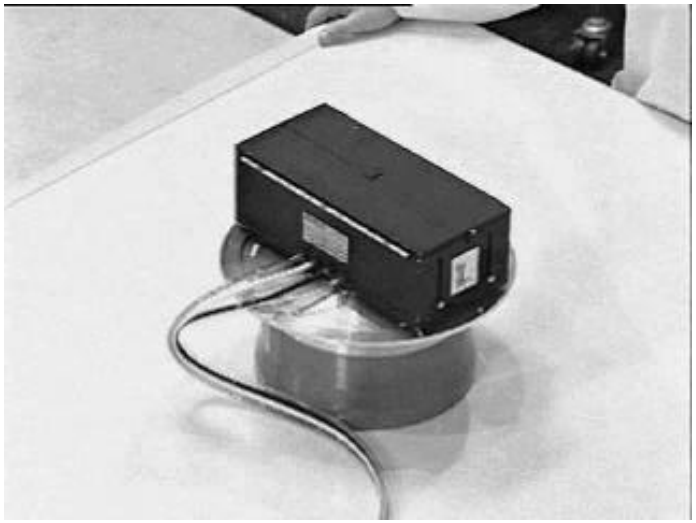
SPACECRAFT PACKAGING



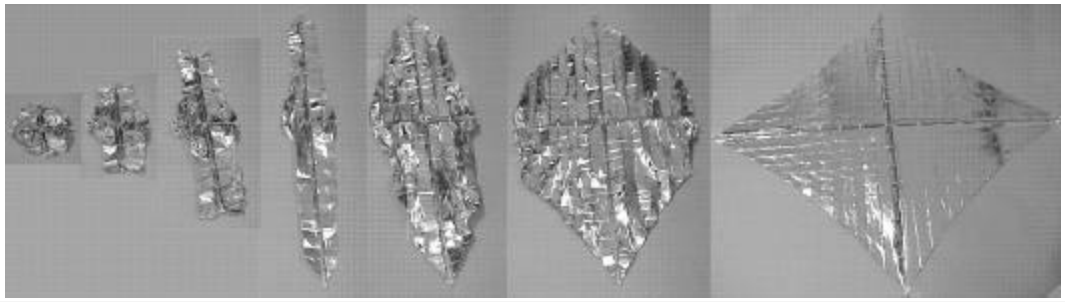
Packaging Specifications

- 60 cm X 60 cm X 15 cm for sail & booms
- Spreader Bars
  - Four 5 cm X 5 cm X 30 cm "table legs"
- Telescopic boom limited by base diameter
- Boom annular packing factor = 1.2
  - Derived from previous telescopic tests (non-isogrid)
- Boom aligned on diagonals of 60 cm X 60 cm pack square
- Sail packaging factor = 5 based on IAE

MAINSAIL DEPLOYMENT



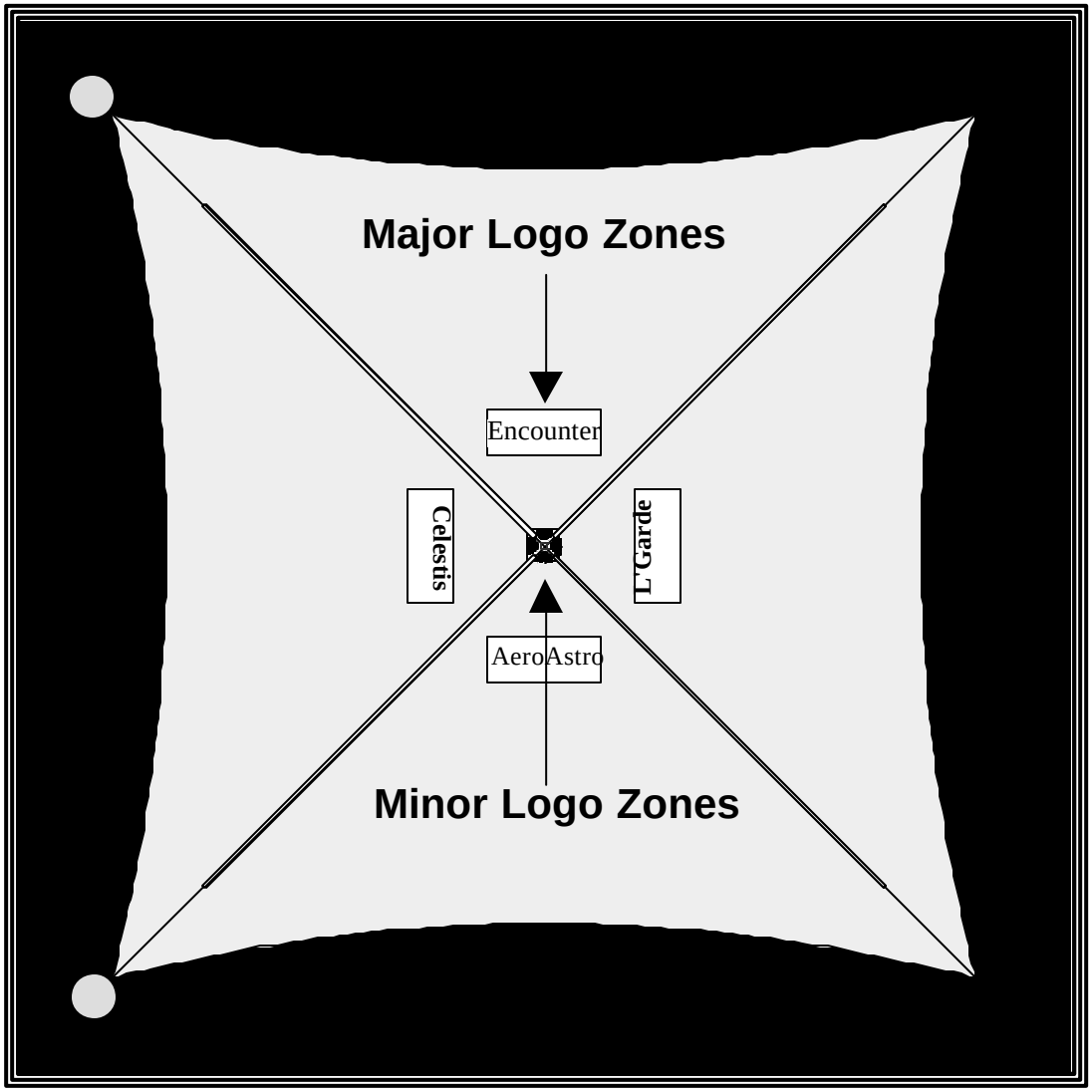
- Sail segments are double z-folded
- Last direction folded is the first direction (first boom axis to deploy
- Boom deployment controls sail deployment
- Base segments deploy first, which is preferable
- Minimal impact on the sail



SPACECRAFT SPECIFICATIONS

- Mass:
  - Sailcraft: 19.0 kg (41.9lbs)
  - Carrier 84.9 kg (187.2 lbs)
  - Total: 103.9 kg (229 lbs)
- Power (Max):
  - Sailcraft: 24 watts
  - Carrier: 93.2 watts
  - Total: 117.2 watts
- Overall spacecraft dimensions: 70 x 58 cm (2.3 ft. x 1.9 ft)
- Overall sail dimensions: 76.4 x 76.4 m (250 x 250 ft.)
- Sail Area: 70 m x 70 m (230 x 230 ft.)
- Boom Length: 54 m (177 ft.)
- Sail material: mylar: 0.9 μm (~0.000035 in.)
- Power source: solar cells
- Communications link: S-Band (located on carrier)
- Velocities:
  - At perigee in GTO: 9.9 km/s (6.2 miles/s) prior to motor burn
  - Earth Escape Velocity: 10.7 km/s (6.7 miles/s)

SAIL LOGOS



Primary Advertising Space

4 Major Logo Zones
4 x 10 m Area
50% Paint Coverage
Center is 10 m from sail center
Effective Performance Cost ~ 300 g
Areal Cost ~ 1%
Mass Cost ~ 160 grams
Must be balanced across sail center

Secondary Advertising Space

12 minor logo zones
20 x 20 cm Area
100% Paint Coverage
Around sail solar arrays
Effective performance cost ~ 5 g

ON BOARD CAMERAS

- **Bandwidth**
  - Good - 183 kbps (1/10 sec)
  - Better - 313 kbps (1/6 sec)
  - Best - 1000 kbps (1/2 sec)

•Image Size and Quality

•Amount of Data Returned

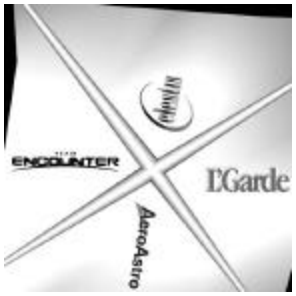
- **9 Ranges of Cameras**
  - COTS - PhotoBit Camera & Nikon Lenses
  - Fisheye lens for close viewing prior to deployment
  - Eight additional cameras with field of view from 2 to 33 degrees

CAMERA VIEWS SIMULATION

Fish Eye Lens View

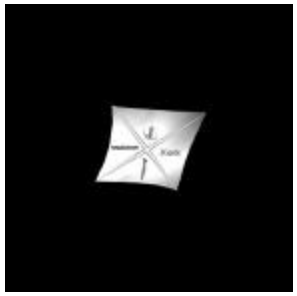
25 m range
2.7 min

50 m range
3.8 min

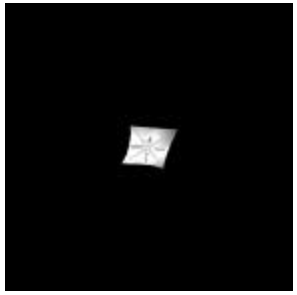


100 m range
5.3 min

200 m range
7.6 min



400 m range
10.8 min

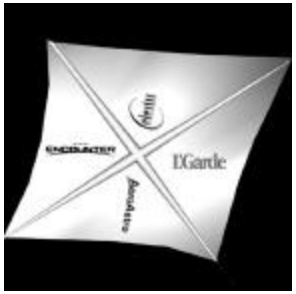


16mm Lens

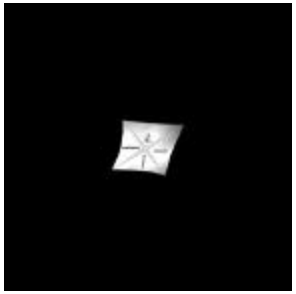
25m range
2.7 min

100m range
5.3 min

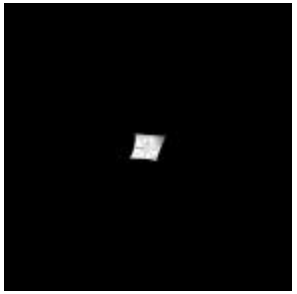
400m range
10.8 min



1600m range
21.7 min



3200m range
30.8 min



PRELIMINARY BUDGET ESTIMATE

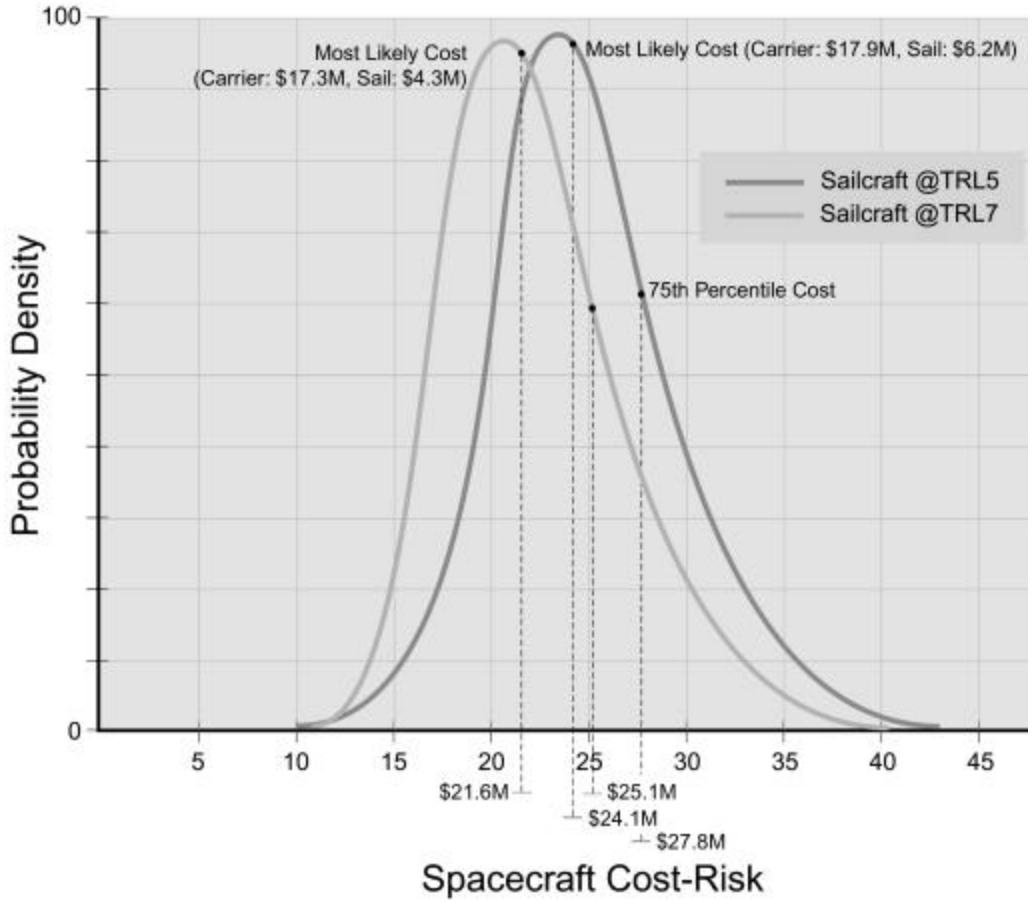
Sailcraft Segment Estimate:	$5.9-$8.0 M
Spacecraft and Ops. Estimate:	$7.3-$9.0 M
Arianespace launch estimate:	$3 M
Total Mission estimate:	**$16.2-20 M**

SCHEDULE MILESTONES

Preliminary Design Review:	**Jan. 2002**
Critical Design Review:	**Oct. 2002**
Environmental Testing:	**Aug. 2003**
Launch:	**Dec. 2003**

Program Cost Assessment: SAA

- **Top-down cost estimate prepared from RAND smallsat cost model**
- **based on 48 missions, 80-500kg.**



[1] Technology Readiness Level (TRL) is a measure of the readiness of a technology for flight, based on a ten scale

Go!

- **If revenue projections hold, SAA recommends Encounter proceed with the mission:**
  - It's feasible
  - It's exciting
  - It's inspiring
- **Likely that revenue could be generated through "public participation" in the progress of the mission (Discovery Channel, NOVA, webcasts, etc.)**